Course Specification

(Postgraduate Programs)

Course Title:	**Nanophysics and Nanotechnology**
Course Code:	**PHY 6265**
Program:	**Master of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	**3**
Last Revision Date:	***26/09/2024***

Table of Contents

A. General information about the course:

1. Course Identification:

1. Credit hours: 3				
2. Course type				
A.	☐ University	☐ College	☒ Department	☐ Track
B.	☐ Required		☒ Elective	
3. Level/year at which this course is offered: Level 3 or 4/Year 2				
4. Course General Description:				
This course introduces the basic principles of nanophysics and nanosciences allowing working in research and development in nanotechnology. Quantum confinement in nanostructures, techniques used for the preparation and characterization nanostructures and semiconductor nanostructures will be developed.				
5. Pre-requirements for this course (if any): None				
6. Pre-requirements for this course (if any): None				
7. Course Main Objective(s):				

At the end of this course, students will be able to:

- **Know some important applications in nanotechnology and understand the reason of the researchers' interest on this technology.**
- **Gain an understanding of the historical importance of the development of the nanotechnology and its limitations.**
- **Understand the emerging science of working and building at near the molecular level.**
- **Be familiar with new strategic materials promising in the near future for nanotechnology;**
- **Explain physical properties when the dimensions of the material are small enough to be comparable to the wavelength of the electrons confined inside. The wave nature of the electrons leads to radically altered electronic properties.**
- **Understand the fundamental concepts and the principles through a broad range of interesting applications in nanotechnology;**

- **Have the opportunity to understand the techniques to solve, through discussion and reading, a wide range of specific theoretical problems, including their backgrounds and implications;**
- **Be adept at the application of physical and mathematical tools to solve real life problems in the considered domain.**

2. Teaching Mode: (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning		
3	Hybrid • Traditional classroom • E-learning		
4	Distance learning		

3. Contact Hours: (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	**30**
2.	**Laboratory/Studio**	**0**
3.	**Field**	**0**
4.	**Tutorial**	**30**
5.	**Others (specify).....**	**0**
	Total	**60**

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods:

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Describe the background and main features of the historical development of nanophysics**	**K1,K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	and nanotechnology and their limitations.			
1.2	**Discuss the techniques used for the synthesis and the characterization of the nanosystems.**	**K1,K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	**Interpret the porosity in the materials: equation of Guswitsch, textural characterization by adsorption-desorption, adsorption isotherms, specific surface area, porous volume and pores distribution.**	**K2,K3**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.4	**Recognize physical phenomena in light of the quantization at different dimensions (3D, 2D, 1D and 0D) and also the effective energy band-gap.**	**K1, K3**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
2.0	**Skills**			
2.1	**Explain and summarize the basic knowledge gained from studying Nanophysics and Technology course.**	**S1, S2**	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	**Develop the students ability to solve and analyze problems in physics related the topics covered by the course.**	**S2, S3**	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	**Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.**	**S4**	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
			homework and assignments. • Use digital library.	
3.0	**Values, autonomy, and responsibility**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework. ▪ Mini-project(s).

C. Course Content:

No	List of Topics	Contact Hours
1.	**Generalities on Nanoscience and Nanotechnology:** History of nanosciences, Fundamental concepts (bottom-up and top-down), Importance of nanosystems, Specific surface area and quantization.	**8**
2.	**Quantization (3D, 2D, 1D and 0D):** Gas of free electron, Energy levels for free electron, Energy densities in 3D, 2D, 1D and 0D. Bohr radius, Effective energy band-gap.	**14**
3.	**Synthesis Techniques of Nanomaterials:** Introduction on nanofabrication, Generalities on germination techniques, Chemical methods like reduction of metallic salts, Electrochemical reduction, Sol-gel technique, Solvothermal technique, Core-schell systems and in-situ synthesis, Physical methods like thermal evaporation, PLD, electric discharge, Sputtering, MBE, CVD, MOCVD and lithography.	**15**
4.	**Characterization Techniques of Nanomaterials** X-rays diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atom Force Microscopy (AFM), Vibrating sample magnetometer (VSM), and Photoluminescence Spectroscopy	**15**
5.	**Some Technological Applications:** Nanoelectronic components. Quantum effects in opto-electronic materials and photocatalytic processes. The underlying quantum effects are discussed, as well as recent developments. In addition, fundamental processes in nanostructured semiconductors, such as used in novel, sensitized solar-cells will be discussed.	**8**
Total		**60**

D. Students Assessment Activities:

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Class Activities (class quizzes, homework, solving problems, etc.....)	weekly	20 %
2.	Midterm Exam 1	6th week	20 %
3.	Midterm Exam 2	12th week	20 %
4.	Final Exam	16th week	40 %

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.)

E. Learning Resources and Facilities:

1. References and Learning Resources:

Essential References	*C. Binns, Introduction to Nanoscience and Nanotechnology, John Wiley & Sons, 2010.*
Supportive References	*Modern Concepts in Nanoscience, 2nd Edition, Wiley-VCH Verlag GmbH & Co. KGaA, 2006.* *C. Binns, Introduction to Nanoscience and Nanotechnology, John Wiley & Sons, 2010.* *-G. Cao, Y. Wang, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, 2nd Edition; World Scientific, 2011.*
Electronic Materials	https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx
Other Learning Materials	Multimedia associated with the textbook and the relevant websites.

2. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	- Classrooms - XRD VSM, SEM/EDAX research Lab
Technology equipment (Projector, smart board, software)	- Classroom equipped with a whiteboard and a projector.
Other equipment (Depending on the nature of the specialty)	

F. Assessment of Course Quality:

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	- Students. - Second examiner	Indirect (The student will complete evaluation forms at the end of semester. Final exam is evaluated by the second examiner)
Effectiveness of students' assessment	- Instructors	Direct (exams, HW, project, ...)
Quality of learning resources	- Faculty - Students	Indirect (surveys)
The extent to which CLOs have been achieved	- Instructors - Program Leaders	Direct (excel sheet)
Other		

Assessor (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval Data:

COUNCIL /COMMITTEE	Quality Unit-Physics Department
REFERENCE NO.	Department council No. 6
DATE	26/09/2024